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ABSTRACT

Space communications have developed tremendously since 1963 when the National Aeronautics and Space Administration (NASA) launched the synchronous communication satellite, Syncom II, into geostationary orbit. The capacity of that spacecraft was one two-circuit voice channel. Intelsat V, launched in 1980, has a capacity of 12,000 circuits plus two television channels. Due to the increasing number of satellites in operation today, space telecommunications plays a major role in regional and domestic systems, as well as in international networks. The cost to the customer or to the final user is constantly decreasing due to coherent program leadership, technological development, and increasing customer demands. Still, the needs for space telecommunications are widely different for the developed countries and for the countries in the process of development. When one tries to estimate the space market for the current decade the main difficulties lie with determining the financial means for funding the projects and with the decision making process in various countries. While the major technical tools required for fulfilling the needs of the 1980s actually exist or are under development, drastic changes may occur in space technology as a shift from satellites to space stations is made and progress occurs in the field of telecommunications. (MKM)

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"SATELLITE COMMUNICATIONS IN THE 1980's"

Prepared for the 1980 Annual Conference of the

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SATELLITE COMMUNICATIONS IN THE 1980'S

Since 1963 when NASA launched the synchronous communications satellite, Syncom II, into geostationary orbit, space communications have developed tremendously. The capacity of that spacecraft was one two-circuit voice channel. In December of this year Intelsat V will be launched with a capacity of 12.000 circuits plus 2 TV channels.

Just as remarkable is the increasing number of satellites in operation, and the variety of services they provide. Today, space telecommunications plays a major role in regional and domestic systems, as well as in international networks.

Most communications satellites are situated in the geostationary orbit. A satellite is a rather expensive device, and the launch into geostationary orbit costs about the same amount of money as the satellite itself.

The cost to the customer or to the final user, however, is constantly decreasing as the number of available circuits aboard each spacecraft increases. The reason behind this economic success is three-fold.

1. Coherent program leadership
   The existence of an efficient international organization for worldwide communications (Intelsat) uniting more than 100 countries, and the active role of national telecommunications and space agencies.

2. Technological development
   The availability of the technologies required, as well as the existence of technical teams needed to design, develop ,and maintain both space and ground segments.

3. Increasing customer demands
   The rapid expansion of customer needs has inspired many technological developments and has been an incentive to finding cost effective solutions.

Space telecommunications are now widely in use and a lot of progress can be expected in the current decade for satellite systems. Let us look first at needs and later at the tools required for fulfilling these needs.

The needs for space telecommunications are widely different for the developed countries and for the countries in the process of development.

The developed countries usually have extensive and efficient networks on the ground for domestic communications.

They strongly need however :

1. to increase worldwide capacity for voice, telex and TV signals,
2. to create or expand specialized networks for high density, rapid transmission of data -several megabits per second- and services for newspapers and electronic mail,
3. to use space as a mean of alleviating the burden on ground networks when they are saturated, or nearly saturated, which is the case in Europe for television broadcasting,
4. to expand specialized services such as meteorology, where satellites are used for gathering imagery of the ground and the earth's atmosphere within the coverage area, and also as a means for transmitting data from main stations to users,
5. to expand military and civilian telecommunications for mobile liaisons with ground vehicles, ships at sea, or aircraft in flight. This usually leads to the creation of specialized networks on an international, as well as on a domestic scale.

Developing countries, on the other hand, usually suffer from an insufficient ground network. Very frequently this situation results not only from lack of financial resources, but also from geographical conditions. Insularity, the presence of vast equatorial forests, desert and mountainous areas are disadvantageous to ground networks, whereas space systems overcome these difficulties easily, when relatively small ground stations are put into operation. Large countries with geographical shortcomings can improve their communication capability either by renting transponders from international

organizations like Intelsat or by using a dedicated satellite better adapted to their specific national requirements. These countries frequently have problems educating their populations, at least in remote parts of their territory. The use of direct or semi-direct TV broadcast satellites may help these countries to overcome the shortage of skilled teachers in addition to improving their telecommunication capacity, thus making it easier to spread basic knowledge to the whole population. Obviously, developing countries will have the same future needs as the developed countries but not with the same priorities or schedule.

Many authors and institutions have attempted to estimate the space market for the current decade. The main difficulties, when one tries to evaluate these studies, lie with the financial means for funding the projects, and with the decision making processes. Generally speaking, it appears that with few exceptions, preliminary procedures within these countries and/or groups of countries are very long, and that decisions are frequently delayed for months and in some case for years. Delays are longest when several countries are involved, and when the country or countries involved suffer from financial difficulties. The most significant exceptions concern well established international organizations like Intelsat, and cases where decisions are made by companies with profit motives or by governmental agencies with adequate budgetary resources Most probably the number of systems actually funded and put into operation will be substantially smaller than the number of systems required by the needs expressed.

The major technical tools needed for fulfilling the needs of the 1980's actually exist, are under development, or are included in programs for development in the near future. Since most of the satellites (with the exception of Molnya Systems) will be designed to be located in the geostationary orbit, a unique and limited natural resource, many problems will no doubt arise.

Frequency reuse by means of dual polarization beams, as well as by the utilization of the same frequencies for up and down links between sufficiently distant ground stations, is now fully developed for spacecraft. Widening the spectrum outside the conventional 4/6 Ghz and 11/14 Ghz links to higher frequencies is another means of overcoming the problem. Already the use of 20 to 30 Ghz links is planned, and experimental missions will soon employ them. Progress in antennas and in altitude control will also make a better use of the available frequencies possible.

Technological advances will bring about significant cost reductions :

- new materials and miniaturization will ensure a better utilization of launch weight, increasing the mass available for telecommunications equipment. Weight saved on the platform can be put to better use on the payload.

- lower cost launches. Development of fully or partially re-usable launch vehicles, utilization of more modern designs, advanced technologies, and more efficient manufacturing processes will lead to lower costs, as will competition between available launching services.

- higher reliability is leading to longer orbital lifetimes. The current requirement is 7 years in orbit and it is possible to increase this life to probably 10 years.

- direct communication from one satellite to another avoiding the necessity of the double jump to and from points which are not in the same geostationary satellite coverage zone.

- increased use of similar components or subsystems when designing and manufacturing new satellites.

No doubt that the trend, which has continued since 1965, for reduction of charges to the customer for satellite transmissions will continue in the present decade, though probably at a lower rate, and thus will make space communications more and more attractive. However, the competition between space and cable communications remains active, and will be stimulated by introduction of transmission through optical fibers. It would be interesting to analyse in more depth the impact of these new and very promising technologies on the telecommunication systems market.

These reflections do not take into account drastic changes in Space technology and essentially the shift from satellites to space stations. Such changes are technically feasible. The Space shuttle will enable man to put very large payloads into low orbits and from there it is possible to lift completely or partially assembled stations to the geostationary orbit. The economics of such a plan are not quite clear today. To make full use of this concept one must obviously have the possibility of maintaining such a station.

The space station would carry a sufficient quantity of redundant subsystems, which could be activated by remote control so as to replace the equipment in which failures are most likely to occur, or whose normal lifetimes are shortest.

Station maintenance requires both emergency missions, such as repairing single point failures in space almost as soon as they occur, and routine maintenance, such as replacing used subsystems which have been switched off. To accomplish this, two alternatives are open to designers. First, the use of maximum automation. Remote investigation techniques -telemetry and television- would determine the cause of the failure and telemanipulation devices would repair or replace equipment. A highly sophisticated vehicle would be required, but the cost would remain that of an unmanned mission.

The second alternative would be a manned spacecraft for maintenance. The cost of manned missions is high because of higher reliability requirements when human life is at stake, and also because of increased weight for life support subsystems : air, food, waste disposal equipment, etc.. The benefits offered by human skills in space must always be weighed against the price of a manned mission.

Considering the high degree of reliability of the systems currently in orbit, it is not likely that the shift from satellites to stations will occur until the 1990's. The geostationary orbit, however, will soon be crowded and perhaps overcrowded, and it may be necessary to use a large orbital antenna form in order to alleviate the problems related to signal interference, antenna patterns, etc..

Besides the advances in spacecraft technologies, much progress can be expected in the field of telecommunications and propagation. Since bandwith is limited, techniques such as signal compression and digitalization may be used in order to make the most of the available links to and from satellites.

Telecommunications, and in particular, space communications have a major impact on large segments of humanity. National communities, groups of countries with regional problems and needs, and even the world community as a whole have benefited, and will continue to do so , from the communications and audio -visual revolution made possible with space. It is the task of groups like the IIC to analyse the problems involved and the means of solving them, sharing ideas and offering possible solutions to common needs to every country in the best interest of all.

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